CLAIMS

1. A method for dynamically managing allocation of bandwidth in a packet network using a Dynamic Setting Scheme (DSS) for Class Based Queuing (CBQ), comprising the steps of:

    maintaining a minimized reserved portion of bandwidth to minimize delay jitter; and

    maximizing a shared portion of bandwidth to maximize overall bandwidth utilization.

2. The method of claim 1 wherein allocation of bandwidth is based on a sharing tree hierarchical scheme that provides for temporary borrowing of bandwidth by real-time applications from bandwidth of non-real-time applications and blocks borrowing of bandwidth by non-real-time applications from bandwidth of real-time applications.

3. The method of claim 1 wherein the DSS provides for using measurable parameters as control triggers for implementing adjustment of bandwidth allocation.

4. The method of claim 3 wherein the measurable parameters include at least one of: queue length and number of borrowing attempts per a predetermined length of time.

5. A method for dynamically managing allocation of bandwidth in a packet network using a Dynamic Setting Scheme (DSS) for Class Based Queuing (CBQ), comprising the steps of:

    measuring a predetermined parameter at predetermined observation window times; and

dynamically adjusting allocated bandwidth for parent classes of real-time traffic by adjusting an average of the predetermined parameter to have a value within a predetermined stable region.

6. The method of claim 5 wherein dynamically adjusting allocated bandwidth is based on a sharing tree hierarchical scheme that provides for temporary borrowing of bandwidth by real-time applications from bandwidth of non-real-time applications and blocks borrowing of bandwidth by non-real-time applications from bandwidth of real-time applications.

7. The method of claim 5 wherein the predetermined parameter measured is one of: queue length and number of borrowing attempts during a predetermined measurement window.

8. The method of claim 5, where the predetermined parameter is a number of borrowing attempts during a measurement window, and a maximum bandwidth and a minimum bandwidth for the predetermined stable region are determined by:

$$If\ A_{i\_avg} < Thr(A_i)^{lower},\ B_i = maximum(B_i - \omega_i^{down}\ , Min(B_i))$$

$$Else\ If\ A_{i\_avg} > Thr(A_i)^{upper},\ B_i = minimum(B_i + \omega_i^{up}, Max(B_i))$$

Where A_i is a number of borrowing attempts during a most recent measurement window and

A_{i_avg} is an average number of borrowing attempts/controlled state;

upper and lower thresholds for the predetermined stable region are preset at predetermined values:

$Thr(A_i)^{lower}$ is a lower threshold for borrowing attempts, where $Thr(A_i)^{lower} > 0$;

$Thr(A_i)^{upper}$ is an upper threshold for borrowing attempts, where $Thr(A_i)^{upper} > Thr(A_i)^{lower}$;

increment and decrement units ω_i^{down} and ω_i^{up} , which denote an update granularity on allocated bandwidth B_i, are preset at predetermined values;

$Max(B_i)$ is a maximum value of allocated bandwidth;

$Min(B_i)$ is a minimum value of allocated bandwidth; and

exponential smoothing technique is used as follows,

$$A_{i\_avg} \leftarrow (1-\alpha)*A_{i\_avg} + \alpha*A_i,$$

where a value of α is preselected as a negative power of two and A_{i_avg} is updated every observation window, a pre-determined parameter in seconds.

9. The method of claim 5, where the predetermined parameter is a queue length, and a lower threshold and an upper threshold for queue length for the predetermined stable region are determined by:

$$If\ Q_{i\_avg} < Thr(Q_i)^{lower},\ B_i = maximum(B_i - \omega_i^{down}\ , Min(B_i))$$

$$Else\ If\ Q_{i\_avg} > Thr(Q_i)^{upper},\ B_i = minimum(B_i + \omega_i^{up}, Max(B_i)),$$

Q_i is an instantaneous measurement of queue length;

Q_{i_avg} is a calculated average value for an average queue length;

upper and lower thresholds are preset at predetermined values:

$Thr(Q_i)^{lower}$ is a lower threshold for queue length, where $Thr(Q_i)^{lower} > 0$;

$Thr(Q_i)^{upper}$ is an upper threshold for queue length where $Thr(Q_i)^{upper} > Thr(Q_i)^{lower}$; and

a queue size for class i, which is also an upper bound for a queue length Q_i, is related to an upper bound on a delay jitter as:

$$Delay\_jitter\_i = \max Q_i / B_i$$

wherein, if a jitter upper bound $Delay\_jitter\_i$ is preselected, then a linear relationship exists between $\max Q_i$ and B_i, an allocated bandwidth.

10. A computer-readable medium having computer-executable instructions for dynamically managing allocation of bandwidth in a packet network using a Dynamic Setting Scheme (DSS) for Class Based Queuing (CBQ), wherein the computer-executable instructions comprise the steps of:

measuring a predetermined parameter at predetermined observation window times; and

dynamically adjusting allocated bandwidth for parent classes of real-time traffic by adjusting an average of the predetermined parameter to have a value within a predetermined stable region.

11. The computer-readable medium of claim 10 wherein dynamically adjusting allocated bandwidth is based on a sharing tree hierarchical scheme that provides for temporary borrowing of bandwidth by real-time applications from bandwidth of non-real-time applications and blocks borrowing of bandwidth by non-real-time applications from bandwidth of real-time applications.

12. The computer-readable medium of claim 10 wherein the predetermined parameter measured is one of: queue length and number of borrowing attempts during a predetermined measurement window.

13. The computer-readable medium of claim 10, where the predetermined parameter is a number of borrowing attempts during a measurement window, and a maximum bandwidth and a minimum bandwidth for the predetermined stable region are determined by:

$$\mathit{If}\ A_{i\_avg} < Thr(A_i)^{lower},\ B_i = maximum(B_i - \omega_i^{down}\ , Min(B_i))$$

$$\mathit{Else\ If}\ A_{i\_avg} > Thr(A_i)^{upper},\ B_i = minimum(B_i + \omega_i^{up}, Max(B_i))$$

Where A_i is a number of borrowing attempts during a most recent measurement window and

A_{i_avg} is an average number of borrowing attempts/controlled state;

upper and lower thresholds for the predetermined stable region are preset at predetermined values:

$Thr(A_i)^{lower}$ is a lower threshold for borrowing attempts, where $Thr(A_i)^{lower} > 0$;

$Thr(A_i)^{upper}$ is an upper threshold for borrowing attempts, where $Thr(A_i)^{upper} > Thr(A_i)^{lower}$;

increment and decrement units ω_i^{down} *and* ω_i^{up} , which denote the update granularity on allocated bandwidth B_i, are preset at predetermined values;

$Max(B_i)$ is a maximum value of allocated bandwidth;

$Min(B_i)$ is a minimum value of allocated bandwidth; and

exponential smoothing technique is used as follows,

$$A_{i\_avg} \leftarrow (1-\alpha)*A_{i\_avg} + \alpha*A_i,$$

where a value of α is preselected as a negative power of two and A_{i_avg} is updated every observation window, a pre-determined parameter in seconds.

14. The computer-readable medium of claim 10, where the predetermined parameter is a queue length, and a lower threshold and an upper threshold for queue length for the predetermined stable region are determined by:

If $Q_{i\_avg} < Thr(Q_i)^{lower}$, $B_i = maximum(B_i - \omega_i^{down}, Min(B_i))$

Else If $Q_{i\_avg} > Thr(Q_i)^{upper}$, $B_i = minimum(B_i + \omega_i^{up}, Max(B_i))$,

Q_i is an instantaneous measurement of queue length;

Q_{i_avg} is a calculated average value for an average queue length;

upper and lower thresholds are preset at predetermined values:

$Thr(Q_i)^{lower}$ is a lower threshold for queue length, where $Thr(Q_i)^{lower} > 0$;

$Thr(Q_i)^{upper}$ is an upper threshold for queue length where $Thr(Q_i)^{upper} > Thr(Q_i)^{lower}$; and

a queue size for class i, which is also an upper bound for a queue length Q_i, is related to an upper bound on a delay jitter as:

$$Delay\_jitter\_i = \max Q_i / B_i$$

wherein, if a jitter upper bound $Delay\_jitter\_i$ is preselected, then a linear relationship exists between $\max Q_i$ and B_i, an allocated bandwidth.

15. A device for dynamically managing allocation of bandwidth in a packet network using a Dynamic Setting Scheme (DSS) for Class Based Queuing (CBQ), comprising:

a parameter measuring unit, coupled to a bandwidth sharing determining unit, for measuring a predetermined parameter at predetermined observation window times; and

the bandwidth sharing determining unit, coupled to the parameter measuring unit, for dynamically adjusting allocated bandwidth for parent classes of real-time traffic by adjusting an average of the predetermined parameter to have a value within a predetermined stable region.

16. The device of claim 15 wherein the DSS for bandwidth allocation is based on a sharing tree hierarchical scheme that provides for temporary borrowing of bandwidth by real-time applications from bandwidth of non-real-time applications and blocks borrowing of bandwidth by non-real-time applications from bandwidth of real-time applications.

17. The device of claim 15 wherein the DSS provides for using measurable parameters as control triggers for implementing adjustment of bandwidth allocation.

18. The device of claim 15 wherein the measurable parameters include at least one of: queue length and number of borrowing attempts per a predetermined length of time.

19. The device of claim 15, where the predetermined parameter is a number of borrowing attempts during a measurement window, and a maximum bandwidth and a minimum bandwidth for the predetermined stable region are determined by:

$$\mathit{If}\ A_{i\_avg} < Thr(A_i)^{lower},\ B_i = maximum(B_i - \omega_i^{down},\ Min(B_i))$$
$$\mathit{Else\ If}\ A_{i\_avg} > Thr(A_i)^{upper},\ B_i = minimum(B_i + \omega_i^{up},\ Max(B_i))$$

Where A_i is a number of borrowing attempts during a most recent measurement window and

A_{i_avg} is an average number of borrowing attempts/controlled state;

upper and lower thresholds for the predetermined stable region are preset at predetermined values:

$Thr(A_i)^{lower}$ is a lower threshold for borrowing attempts, where $Thr(A_i)^{lower} > 0$;

$Thr(A_i)^{upper}$ is an upper threshold for borrowing attempts, where $Thr(A_i)^{upper} > Thr(A_i)^{lower}$;

increment and decrement units ω_i^{down} *and* ω_i^{up} , which denote the update granularity on allocated bandwidth B_i, are preset at predetermined values;

$Max(B_i)$ is a maximum value of allocated bandwidth;

$Min(B_i)$ is a minimum value of allocated bandwidth; and

exponential smoothing technique is used as follows,

$$A_{i\_avg} \leftarrow (1-\alpha)*A_{i\_avg} + \alpha*A_i,$$

where a value of α is preselected as a negative power of two and A_{i_avg} is updated every observation window, a pre-determined parameter in seconds.

20. The device of claim 15, where the predetermined parameter is a queue length, and a lower threshold and an upper threshold for queue length for the predetermined stable region are determined by:

$$If\ Q_{i\_avg} < Thr(Q_i)^{lower},\ B_i = maximum(B_i - \omega_i^{down}, Min(B_i))$$

$$Else\ If\ Q_{i\_avg} > Thr(Q_i)^{upper},\ B_i = minimum(B_i + \omega_i^{up}, Max(B_i)),$$

Q_i is an instantaneous measurement of queue length;

Q_{i_avg} is a calculated average value for an average queue length;

upper and lower thresholds are preset at predetermined values:

$Thr(Q_i)^{lower}$ is a lower threshold for queue length, where $Thr(Q_i)^{lower} > 0$;

$Thr(Q_i)^{upper}$ is an upper threshold for queue length where $Thr(Q_i)^{upper} > Thr(Q_i)^{lower}$; and

a queue size for class i, which is also an upper bound for a queue length Q_i, is related to an upper bound on a delay jitter as:

$$Delay\_jitter\_i = \max Q_i / B_i$$

wherein, if a jitter upper bound $Delay\_jitter\_i$ is preselected, then a linear relationship exists between $\max Q_i$ and B_i, an allocated bandwidth.